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AUTHOR	Halpin, Pat; Kossegi, Joanne D.
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ABSTRACT

The use of modern technologies has become common in mathematics education and is considered necessary for good mathematics instruction. To effectively integrate technology into the curriculum, teachers must learn new behaviors and practices and discover that the changes result in positive student outcomes. The inherent difficulties involved with in-service training underscore the importance of ensuring that preservice teachers enter the field with an adequate technical background. Preservice teachers must learn how to incorporate technology into their everyday teaching style in a meaningful manner. Technology can be used as a vehicle to change the role of both student and teacher in the classroom. This paper describes a course at the State University of New York (SUNY) at Oswego called "Problem Solving" which lends itself to the application of technology. Each student is required to find a mathematics problem suitable for secondary students on the World Wide Web and make a presentation based on the problem. Two problems found on the Web and various educational Web sites are described. A survey of the class indicates that they believe the use of modern technology as a teaching tool will have a significant and positive impact on their teaching careers. The survey and educational Web site addresses are provided. (SWC)

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The WWW, Preservice Teachers and their Mathematics Courses

Pat Halpin
Joanne D. Kossegi
Mathematics Department
State University of New York- Oswego,
Oswego, NY 13126
(315) 341-2733 or 2740
halpin@oswego.oswego.edu
kossegi@oswego.oswego.edu

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Mathematics, science and technology are in the midst of a knowledge explosion. Documents at the national, state and local levels are strongly recommending a new paradigm for mathematics, science, and technology education. At the national level, the National Council of Teachers of Mathematics (NCTM) *Standards* made specific recommendations for the way we should teach school mathematics. Those recommendations are now being looked at by schools in higher education. In 1991, the New York Board of Regents adopted A New Compact For Learning. This Compact sets forth a comprehensive strategy for improving public education results in this decade. In 1994 the New York State Education Department developed a new document which provides a structure for integrating mathematics, science and technology Mathematics, Science and Technology Curriculum Framework. The Framework specifies in broad terms the skills and knowledge that students should acquire, sets forth standards of curriculum content and student performance, and provides illustrations of effective teaching and assessment. In recent years the use of modern technologies has become common in the mathematics classroom. Indeed graphing calculators are mandatory in AP calculus classes. The current NCTM Standards state:

> " Calculators, computers, courseware, and manipulative material are necessary for good mathematics instruction; the teacher can no longer rely solely on chalk, paper and a text. Note however, that simply providing teachers with these materials will not produce a new program; teachers must also know how to integrate this technology into a quality mathematics program."

To change this cultural norm, teachers will need to learn new behaviors, practice them, and discover that the changes result in positive student outcomes. (Joyce and Showers 1988). Expertise development is time consuming. Studies investigating changes in knowledge and beliefs of teachers which result from teacher education programs report that lasting change occurs only after an extended period (Hollingsworth [1990], Sparks-Langer and Colton [1991]). Lappan et al. [1983] expressed similar sentiments. In their final report to the NSF on their middle school mathematics project they write as follows

> "The major implication of this study is that changing teachers' beliefs and practices require a substantial long-term staff development program. We believe that an intervention that provides less than two years of intellectual and emotional support for teachers is unlikely to have any lasting effect. Even if the staff development goals are to implement specific curriculum ideas, teachers need support through at least two rounds of working with these ideas."

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Our experience with mathematics teachers in our local area is consistent with these findings. Moreover, there is generally little structure in place for significant long term staff development. Recent initiatives by various federal agencies have attempted to address this problem but of course most schools are not involved. The inherent difficulties involved with in-service training underscore the importance of ensuring that our preservice teachers enter the field with an adequate technical background.

How then should we prepare our prospective teachers in the use of modern technologies? It is not sufficient to confer technical ability on a particular topic or device. Such training is of little value unless the preservice students also learn how to incorporate this technology into their future classrooms in a sound and meaningful manner. The ability to successfully integrate new technology into one's everyday teaching style is crucial to its success. We strongly promote the idea that technology can be used as a vehicle to change the role of both student and teacher in the classroom. Students become active participants in the learning process instead of passive repositories of knowledge delivered from the teacher.

One course at SUNY Oswego which easily lends itself to the application of technology is Problem Solving. This is a required course for all secondary mathematics majors. The goals of the course include

1) to increase problem solving skills;
2) to become familiar with some of the available resources related to problem posing and solving; and
3) to learn to successfully incorporate problem posing and solving into one's teaching style.

There are many traditional resources for problems. These include problem books, journals related to the teaching of mathematics, collections of contest problems, and various magazine puzzle sections. Unfortunately, many of these sources for problems are not readily available to secondary teachers. Of course the newest and most exciting resource is the Internet or world wide web. We believe this tool will be available to virtually all secondary teachers in the very near future.

One project that each student in Problem Solving was given was to find a mathematics problem suitable for secondary students on the Web and make a presentation based on this problem to the class. Each member of the class then made individual evaluations of the presentation. These evaluations were eventually returned to the presenter. The students in this class quickly found that there are an immense number of Web sites that provide problems that are appropriate for secondary students.

The following problem is an excellent example of the type of problem that was found and used by the students in the class. We wish to thank Suzanne Alejandre for granting us permission to use her problem. The problem is to construct a 3 by 3 "magic square". A magic square is a square array of integers which has the property that the sum of any row or column is identical. They are very interesting objects which may be studied by students at all levels of ability. Suzanne gives a solution which involves a general construction scheme. The presentation which the student made on this problem was well received by the class and yielded a lively discussion.

A Math Forum Web Unit

Suzanne Alejandre's

Magic Squares

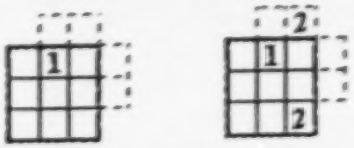
Building a 9-Cell Square

Back to Suzanne's Math Lessons || Check out Suzanne's Tessellation Lessons

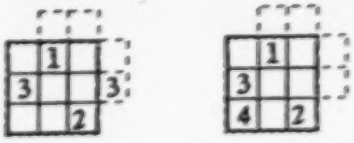
Directions:

1. Draw a 9-cell grid and place your first number in the center cell of the top line.

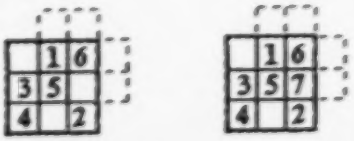
2. Extend your grid, but remember that the dotted cells are actually outside of the grid. Always work to place your numbers consecutively above and to the right: the **number 2** ends up in a dotted position. To place the **number 2** within the grid, bring it to the opposite end of the row.



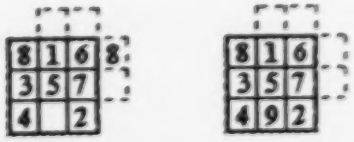
3. Place the **number 3** above and to the right. Since it is in a dotted area, it goes to the other end of the row. The **number 4** cannot go above and to the right, so drop it just below.



4. **Numbers 5 and 6** will go above and to the right. The **number 7** can't go above and to the right, so it drops below the number 6.



5. The **number 8** goes above and to the right in a dotted area - so it moves to the other end of that row. The **number 9** has only one place left to go!



Students in Mathematics for the Elementary Teacher classes were assigned to search the World Wide Web for two different sites that would be useful to them as teachers or to their future students. Once at these sites they looked for information beneficial to the mathematics community. The majority of the students had never used the Internet. After one class in the Macintosh computer lab where we accessed Netscape, they were on their own to "surf the net" in mathematics education.

Some of the sites the preservice teachers investigated were *Math Forum- Student Center, Math Forum -Teachers' Place, Geometry Through Art, Math Magic, Using Literature to Teach Math, Ask Dr. Math, K-12 Website for Busy Teachers, MathlandThe Grocer yStore*, etc. As you can see, whatever mathematical resource you need, it will most likely be on the Web. Lesson plans, book and software reviews are there too. A sample from the *Math Forum- Student Center* follows.

Elementary Problem of the Week, April 15-19,1996

This week's problem was submitted by Jody Newman, Center School, Stow MA.

Once there lived a farmer, his wife, and their three sons. When the farmer died, his will said that the eldest son was to receive one-half of what he owned, the middle son was to receive one-third, and the youngest son was to receive one-ninth. All the farmer owned, however, was seventeen horses. And try as they might, the three sons could not figure out any way to divide the seventeen horses by their fathers wishes.

"Don't worry," their mother told them. "We can solve this with a little help."

She went to the neighboring farm and borrowed a horse. Then with a total of eighteen horses, she gave the eldest son one-half, or nine horses. She gave the middle son one-third, or six of the horses. And she gave the youngest son one-ninth, or two of the horses.

"There," she said. "Nine plus six plus two makes the seventeen horses your father left you." And she returned the eighteenth horse to the neighbor.

How did she do it?

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How does this site prove beneficial to teachers and students? The *Math Forum- Student Center* links high school students with elementary school children through the "Problem of the Week". A student who registers her response to one of these challenging problems receives a reply from a high school student who then becomes her math mentor. Both students are winners; the elementary school child gains valuable problem solving experience while the high school student, applying acquired mathematical knowledge, gains confidence in his own ability. The *Math Forum-Teachers' Place* offers teachers valuable resources ranging from the latest classroom materials to discussion groups.

It seemed to us that this initial experimentation with the Web was a success for our preservice students. In an attempt to measure our students' attitudes on the use of the Web and technology in

general we gave the following survey. The survey reflects the attitudes of a relatively small number of students and we draw no general conclusions. For this particular group it would seem that they believe that the use of modern technology as a teaching tool will have a significant and positive impact on their teaching careers.

1. The web is easy to use, even for a novice.

1. strongly agree	2. agree	3. not sure	4. disagree	5. strongly disagree
7%	**80%**	**7%**	**7%**	

2. As a future teacher, the web contains resources that would aid me in the classroom.

1. strongly agree	2. agree	3. not sure	4. disagree	5. strongly disagree
40%	**47%**	**13%**		

3. The web would be valuable to my future students if they have access to it.

1. strongly agree	2. agree	3. not sure	4. disagree	5. strongly disagree
33%	**60%**	**7%**		

4. It's easier to use a library than to use the web when searching for resources.

1. strongly agree	2. agree	3. not sure	4. disagree	5. strongly disagree
20%	**47%**	**33%**		

5. If computers are available in my future mathematics classroom, then I will make use of them.

1. strongly agree	2. agree	3. not sure	4. disagree	5. strongly disagree
47%	**47%**	**7%**		

6. I think that being familiar with modern technology will be important to my future successful teaching.

1. strongly agree	2. agree	3. not sure	4. disagree	5. strongly disagree
67%	**27%**	**7%**		

7. I think that being familiar with modern technology will be important in my successful search for a teaching position.

1. strongly agree	2. agree	3. not sure	4. disagree	5. strongly disagree
40%	**40%**	**13%**	**7%**	

8. I think that if students are allowed access to the web during school hours then they will waste too much time and learn little.

1. strongly agree	2. agree	3. not sure	4. disagree	5. strongly disagree
		47%	**53%**	

9. I think that the web will provide a valuable means for me to keep in touch with other mathematics teachers after I find a teaching position.

1. strongly agree	2. agree	3. not sure	4. disagree	5. strongly disagree
27%	**60%**	**13%**		

10. I think that modern technology will ultimately hurt our school education system.

1. strongly agree	2. agree	3. not sure	4. disagree	5. strongly disagree
		7%	67%	27%

One group of preservice students remarked"We had no idea that there was that much information on the internet. Now that we are aware of all the different activities which could be helpful to us, we will definitely take advantage of what the internet has to offer teachers." Nor did we! At this time, there are over 66,000 sites for mathematics and 11,000 for teachers. It's mind-boggling! Are they all worthwhile? That's another discussion. Here are some sites used by our students.

WWW ADDRESSES

http//forum.swarthmore.edu/students
http//forum.swarthmore.edu/mathmagic/what.html
http//forum.swarthmore.edu/dr.math/dr-math.html
http//forum.swarthmore.edu/~sarah/shapiro/ (Geometry through Art)
http//gopher.ed.gov/pubs/parents/math.mathland.html
(MathlandThe Grocery Store)
http//unite2.tisl.ukan.edu/browser/UNITEResource/Layer_Mathematics.html
(Using Literature to Teach Math)
http//www.gatech/edu/lcc/idt/Students/Cole/Proj/K-12/TOC/html
(K-12 Website for Busy Teachers)
http//www.hmco.com/school/math/brain
http//www.civeng.carleton.ca/Problems/
http//marin.K12.ca.us/~sfdhs/math/math.html
(Drake High School Math Department)

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